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Proposal for the Definitions of Automated Driving under WP.29 and the General Principles for developing a UN Regulation on automated vehicles

Submitted by the Informal Working Group on Intelligent Transport Systems / Automated Driving*

The text reproduced below was prepared by the experts from Informal Working Group (IWG) on Intelligent Transport Systems / Automated Driving (ITS/AD). It is based on ECE/TRANS/WP.29/2017/145, distributed in English only during the 173th session of WP.29.

* In accordance with the programme of work of the Inland Transport Committee for 2016–2017 (ECE/TRANS/254, para. 159 and ECE/TRANS/2016/28/Add.1, cluster 3.1), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

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A proposal for the Definitions of Automated Driving under WP.29 and the General Principles for developing a UN Regulation on automated vehicles

1. The following table reflects the general principles and definitions for automated driving systems as relevant for WP.29 to date. These principles are expected to be treated as guidelines for developing a new Regulation related to automated driving systems at WP.29 if appropriate. Please note that:

(a) The control systems that intervening in case of emergency (AEB, ESC, Dead man, etc.) are not included in these definitions of automated driving;

(b) The control functions that avoid dangers caused by unpredictable traffic conditions (goods/luggage dropping, frozen road, etc.) or other drivers' illegal driving behaviors are not considered in this table.

2. A UN Regulation on Automated Driving would need to have new specific performance requirements and verification tests under various conditions as appropriate depending on each level.

3. In discussing system requirements, it is desirable to organize them by level as well as by roadway type and to include the range of vehicle types (1: parking area; 2: motorway; 3: urban and interurban road, and both automated vehicles (i.e. existing vehicle classes) and low-speed shuttle buses, pod cars, etc (i.e. new classes of vehicles).

4. The following table shows distinctive criteria of level of automated driving for the purpose of WP.29 activities to date, considering the results of discussions so far and the assumed use cases. This table should be reconsidered appropriately in accordance with each concept of automated driving system to be placed on the market in the future.

	Object and Event Detection and Response (OEDR) by the driver *The driver may not perform secondary activities*			*Object and Event Detection and Response (OEDR) by the system* *The driver may perform secondary activities*		
	Monitor by Driver	*Monitor by Driver (a)*	*Monitor by Driver (b)*	*Monitor by System (Return to Driver Control on System Request)*	*Monitor by System Full Time under defined use case*	*Monitor by System only*
Ref. SAE Level (J3016)	*1*	*2*		*3*	*4*	*5*
Outline of Classification	System takes care of longitudinal or lateral control Monitoring by the driver	The system takes care of both longitudinal and lateral control Monitoring by driver necessary because the system is not able to detect all the situations in the ODD The driver shall be able to intervene at any time		The system is able to cope with all dynamic driving tasks within its Operational Design Domain (ODD)* or will otherwise transition to the driver offering sufficient lead time (driver is fallback) The system drives and monitors (specific to the ODD) the environment The system detects system limits and issues a transition demand if these are reached * The Level 3 system is e.g. not expected to provide a corridor for emergency vehicle access or to follow hand signals given by traffic enforcement officers. The driver needs to remain sufficiently vigilant as to acknowledge and react on these situations (e. g. when he hears the sirens of an emergency vehicle in close vicinity)	The system is able to cope with any situations in the ODD (fallback included) The driver is not necessarily needed during the specific use-case, e. g. Valet Parking/ Campus Shuttle The system may however request a takeover if the ODD boundaries are reached (e g. motorway exit)	The system is able to cope with any situations on all road types, speed ranges and environmental conditions No driver necessary

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Vehicle Tasks	1. Execute either longitudinal (acceleration/ braking) or lateral (steering) dynamic driving tasks when activated. The system is not able to detect all the situations in the ODD.	1. Execute longitudinal (accelerating, braking) and lateral (steering) dynamic driving tasks when activated. The system is not able to detect all situations in the ODDs.	1. Execute longitudinal (accelerating/braking) and lateral (steering) portions of the dynamic driving task when activated. Shall monitor the driving environment for operational decisions when activated.	1. Execute longitudinal (accelerating/braking) and lateral (steering) portions of the dynamic driving task when activated. Shall monitor the driving environment for any decisions happening in the ODD (for example Emergency vehicles).	1. Monitor the driving environment.
	2. System deactivated immediately at the request of the driver.	2. System deactivated immediately upon request by the human driver.	2. Permit activation only under conditions for which it was designed. System deactivated immediately at the request of the driver. However the system may momentarily delay deactivation when immediate human takeover could compromise safety.	2 Permit activation only under conditions for which it was designed. System deactivated immediately at the request of the driver. However the system may momentarily delay deactivation when immediate human takeover could compromise safety.	2. Execute longitudinal (accelerating/ braking) and lateral (steering).
		3. No transition demand as such, only warnings.	3. System automatically deactivated only after requesting the driver to take-over with a sufficient lead time; may – under certain, limited circumstances – transition (at least initiate) to minimal risk condition if the human driver does not take over. It would be beneficial if the vehicle displays used for the secondary activities were also used to improve the human takeover process.	3. Shall deactivate automatically if design/boundary conditions are no longer met and must be able to transfer the vehicle to a minimal risk condition. May also ask for a transition demand before deactivating.	3. Execute the OEDR subtasks of the dynamic driving task- human controls are not required in an extreme scenario.
		4. A driver engagement detection function (could be realized, for example, as hands-on detection or monitoring cameras to detect the driver's head position and	4. Driver availability recognition shall be used to ensure the driver is in the position to take over when requested by the system. Potential technical solutions	4. Driver availability recognition shall be used to ensure the driver is in the position to take over when requested by transition demand. This	4. System will transfer the vehicle to a minimal risk condition.

		eyelid movement etc.) could evaluate the driver's involvement in the monitoring task and ability to intervene immediately	range from detecting the driver's manual operations to monitoring cameras to detect the driver's head position and eyelid movement	can however be lighter solutions than for level 3 because the system is able to transfer the vehicle to a minimal risk condition in the ODD	
			5. Emergency braking measures must be accomplished by the system and not expected from the driver (due to secondary activities)	5. Emergency braking measures must be accomplished by the system and not expected from the driver (due to secondary activities)	
Driver Tasks	1. Determine when activation or deactivation of assistance system is appropriate	1. Determine when activation or deactivation of the system is appropriate	1. Determine when activation or deactivation of the automated driving system is appropriate	1. Determine when activation deactivation of the automated driving system is appropriate	1. Activate and deactivate the automated driving system
	2. Monitor the driving environment. Execute either longitudinal (acceleration/braking) or lateral (steering) dynamic driving task	2. Execute the OEDR by monitoring the driving environment and responding if necessary (e.g. emergency vehicles coming)	2. Does not need to execute the longitudinal, lateral driving tasks and monitoring of the environment for operational decisions in the ODD	2. Does not need to execute the longitudinal, lateral driving tasks and monitoring of the environment in the ODD	2. Does not need to execute the longitudinal, lateral driving tasks and monitoring of the environment during the whole trip
	3. Supervise the dynamic driving task executed by driver assistance system and intervening immediately when required by the environment and the system (warnings)	3. Constantly supervise the dynamic driving task executed by the system. Although the driver may be disengaged from the physical aspects of driving, he/she must be fully engaged mentally with the driving task and shall immediately intervene when required by the environment or by the system (no transition demand by the system, just warning in case of misuse or failure)	3. Shall remain sufficiently vigilant as to acknowledge the transition demand and acknowledge vehicle warnings, mechanical failure or emergency vehicles (increase lead time compared to level 2)	3. May be asked to take over upon request within lead time. However the system does not require the driver to provide fallback performance under the ODD	3. Determine waypoints and destinations

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	4. The driver shall not perform secondary activities which will hamper him in intervening immediately when required.	4. The driver shall not perform secondary activities which will hamper him in intervening immediately when required.	4. May turn his attention away from the complete dynamic driving task in the ODD but can only perform secondary activities with appropriate reaction times. It would be beneficial if the vehicle displays were used for the secondary activities.	4. May perform a wide variety of secondary activities in the ODD.	4. May perform a wide variety of secondary activities during the whole trip.
	Consideration points on development of vehicle regulation	1. Consider whether regulatory provision for longitudinal (accelerating, braking) and lateral control (steering) are necessary.	1. Consider which regulatory provision for longitudinal (accelerating, braking) and lateral control (steering) are necessary including the monitoring of the driving environment.	1. Consider which regulatory provision for longitudinal (accelerating, braking) and lateral control (steering) are necessary including the monitoring of the driving environment for any decisions happening in the use case (for example Emergency vehicles).	Note: Preliminary analysis only - subject further review. 1. Consider which regulatory provision for longitudinal (accelerating, braking) and lateral control (steering) are necessary including the monitoring of the driving environment for any decisions (for example Emergency vehicles).
		2. Consider regulatory provision to ensure the system is deactivated immediately upon request by the human driver.	2. Consider regulatory provision to ensure the system i) Permits activation only under conditions for which it was designed, and ii) Deactivates immediately upon request by the driver. However the system may momentarily delay deactivation when immediate driver takeover could compromise safety.	2. Consider regulatory provision to ensure the system. i) Permits activation only under conditions for which it was designed, and ii) Deactivates immediately upon request by the driver. However the system may momentarily delay deactivation when immediate driver takeover could compromise safety.	2. Depending upon the vehicle configuration, consider regulatory provision to ensure the system. i) Permits activation only under conditions for which it was designed, and ii) Deactivates immediately upon request by the driver. However the system may momentarily

					delay deactivation when immediate driver takeover could compromise safety
		3. Consider the warning strategy to be used. This might include warning informing the driver in due time when an intervention by the driver is needed	3. Consider regulatory provision to ensure the system automatically deactivates only after requesting the driver to take-over with a sufficient lead time, including – under certain, limited circumstances – transition (at least initiate) to minimal risk condition if the driver does not take over. It would be beneficial if the vehicle displays used for the secondary activities were also used to improve the human takeover process	3. Consider regulatory provision to ensure the system automatically transfer the vehicle to a minimal risk condition preferably outside of an active lane of traffic if design/boundary conditions are no longer met	3. Consider regulatory provision to ensure the system automatically transfer the vehicle to a minimal risk condition preferably outside of an active lane of traffic.
		4. Consider the driver availability recognition function to evaluate the driver's involvement in the monitoring task and ability to intervene immediately. For example, as hands-on detection or monitoring cameras to detect the driver's head position and eyelid movement etc.	4. Consider regulatory provision for driver availability recognition is used to ensure the driver is in the position to take over when requested by the system.	4. Consider regulatory provision for driver availability recognition is used to ensure the driver is in the position to take over when requested by the system transition demand at the end of the ODD.	
			5. Consider regulatory provision for emergency braking measures by the system.	5. Consider regulatory provision for emergency braking measures by the system.	4. Consider regulatory provision for emergency braking measures by the system.

Examples of the necessary system performance requirements						
Override (e.g. steering, braking, accelerating) function by the driver	Necessary in general				Unnecessary when driverless mode Otherwise necessary in general. However the system may momentarily delay deactivation when immediate human takeover could compromise safety.	Unnecessary
Aspects of arrangement that ensures the driver's involvement in dynamic driving tasks (driver monitoring, etc.)	Detection of hands-off when Level 1 addresses LKAS.	Detection of hands-off.	Detecting the driver availability recognition function to evaluate the driver's involvement in the monitoring task and ability to intervene immediately (e.g. hands off detection, head and/or eye movement and/or input to any control element of the vehicle).	Detection of driver's availability to take over the driving task upon request or when required. e.g. seated/unseated. driver availability recognition system (e.g. head and/or eye movement and/or input to any control element of the vehicle).	Unnecessary when driverless operation/use case. Necessary when driver is requested to take over at the end of ODD. In these circumstances, this can be lighter solutions than for level 3 because the system is able to transfer the vehicle to a minimal risk condition in the ODD.	Unnecessary
Aspects of arrangement that ensures the driver's resumption of dynamic driving tasks (transition periods to the driver, etc.) **Aspect of transition demand procedure.**	Not applicable			Consideration of the methods used to reengage the driver following system request (including minimal risk maneuver and cognitive stimulation- if applicable the vehicle infotainment system showing non-driving relevant content to be deactivated automatically when transition demand is issued).	Unnecessary when driverless operation/use case but level 3 requirement when the end of the ODD is reached.	Unnecessary

System reliability	Consideration shall be given to evaluation of the system reliability and redundancy as necessary.				
Comprehensive recognition of surrounding environment **(sensing, etc.)**	The area to be monitored (depends on the system function)	The area to be monitored necessary for lateral and longitudinal control (depends on the system function, while recognizing it is the task of the driver to perform OEDR)	The area to be monitored necessary for lateral and longitudinal control (depends on the system function, while recognizing it is the task of the driver to perform OEDR). Additionally the system may perform OEDR function	The area to be monitored depends on the system function (Lateral and longitudinal directions). It is the task of the system to perform OEDR.	
Recording of system status (inc. system behavior) **(DSSA-Data Storage System for ACSF, EDR, etc.)**	Unnecessary	Unnecessary	The driver's operations and the system status (incl. system behavior)	The driver's operations and the system status (incl. system behavior)	The system status (incl. system behavior))

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Cyber-Security	Necessary if the information communication in connected vehicles, etc. affects the vehicle control					
Compatibility with traffic law (WP.1)	Yes	Yes	Yes	Functionalities that include a human driver, are in general allowed by the road traffic conventions, but the implementation in local traffic rules is not harmonized. Driver might not be able, for example, to perform other activities than driving, thus national traffic laws might need amendments. Following principles have been agreed upon in the WP.1 regarding side activities: Principle 1: these activities do not prevent the driver from responding to demands from the vehicle systems for taking over the driving task, and Principle 2: these activities are consistent with the prescribed use of the vehicle systems and their defined functions.	Further consideration necessary to reflect driverless systems before a conclusion can be made	Further consideration necessary to reflect driverless systems before a conclusion can be made

<table>
<tr><th colspan="5">Summary of the current conditions and the issues to be discussed (specific use cases)</th></tr>
<tr><td>Parking area</td><td rowspan="4">Already put into practice:
· Parking Assist
· LKA (draft standards)
· ACC (no specific performance requirements)
· ACSF Cat.B1 (Steering Function hands-on)</td><td colspan="2">· Automated parking by the driver's remote control (monitoring) (RCP-Remote Control Parking, CAT. A under ACSF amendment of R79)</td><td colspan="2">Requirements need to be developed</td></tr>
<tr><td>Roads exclusively for motor vehicles with physical separation from oncoming traffic (e.g. motorway)</td><td colspan="2">· Categories B2*, C, D and E* under ACSF (amendment of R79)
· Category B1 in combination with longitudinal control</td><td>· Categories B2, B2+E under ACSF (amendment of R79)</td><td>Requirements need to be developed</td></tr>
<tr><td></td><td>· ACC+ACSF (Cat.B1, Cat.C [Basic Lane Change Assist], Cat.D [Smart LCA])</td><td>· ACSF Cat. B2*
· ACSF Cat.E* (Continuous Lane Guidance hands-off)</td><td></td><td></td></tr>
<tr><td>Urban and interurban roads</td><td colspan="2">· Category B1 in combination with longitudinal Control
· To be discussed by R79 IWG ACSF
Cat. B1 in combination with C, D</td><td colspan="2">Requirements need to be developed</td></tr>
</table>

* The functions of Category B2 and Category E of ACSF are allowed in the range of level 3, but if national traffic law prohibits secondary activities, these functions will be used as level 2. In the case of level 2, appropriate driver activity recognition means shall be required for Categories B2 and E of ACSF to ensure constant continuous monitoring by the driver.

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